(12) UK Patent Application (19) GB (11) 2 103 167 A

(21) Application No 8208931
(22) Date of filing 26 Mar 1982
(30) Priority data
(31) 377951
(32) 20 May 1981
(33) Canada (CA)
(43) Application published 16 Feb 1983
(51) INT CL³ B64C 27/10 27/605
(52) Domestic classification B7W 101 102 109 HH HRM B7G 4 8A 8X
(56) Documents cited
GB 1474831
GB 1369411
US 4123018
James' all the World's Aircraft 1975—76 p. 532 "Canadair CL227"
James' all the World's Aircraft 1979—80 pp. 616, 617 "Canadair CL227"
(58) Field of search B7W
(71) Applicant
Canadair Limited, (Canada), P.O. Box 6087, Station A, Montreal, Quebec, Canada, H3C 3G9
(72) Inventor
John P. Kerr
(74) Agents
Brookes and Martin, High Holborn House, 52/54 High Holborn, London, WC1V 6SE

(54) **Unmanned remotely piloted aircraft**

(57) An unmanned remotely piloted aircraft has a pair of rigid counter rotating propellers 17 and 18 positioned substantially at or slightly below, the height of the centre of mass of the aircraft. This results in the production of a sufficiently large control moment to permit the use of a tether line 35 for landing the aircraft. An upper spheroidal portion 1 houses an engine 4 and an annular fuel tank 6, the engine driving the propellors via a gearbox 19. A lower spheroidal portion 3 houses a pay load 12 of surveillance equipment, and flight control units 10. Landing gear 14 comprises a ring 15 connected to the portion 3 by shock-absorber struts 16.

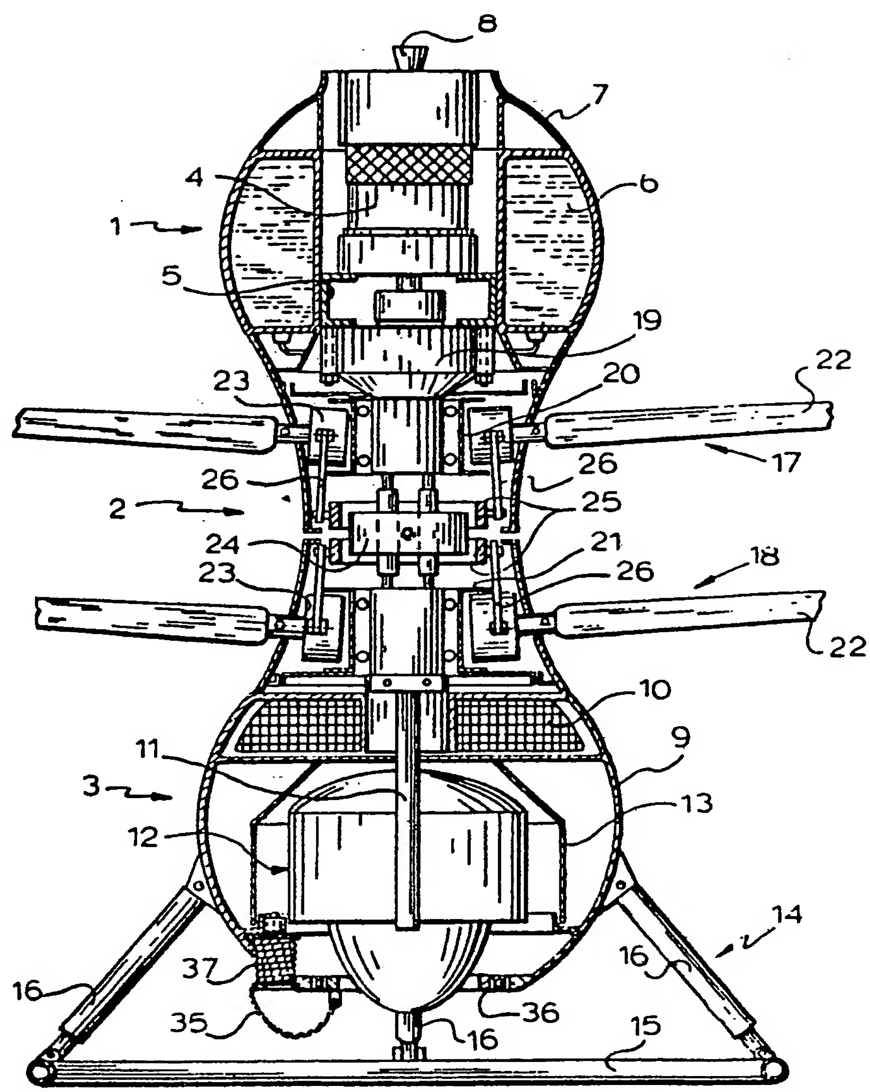

FIG. 1

GB 2 103 167 A

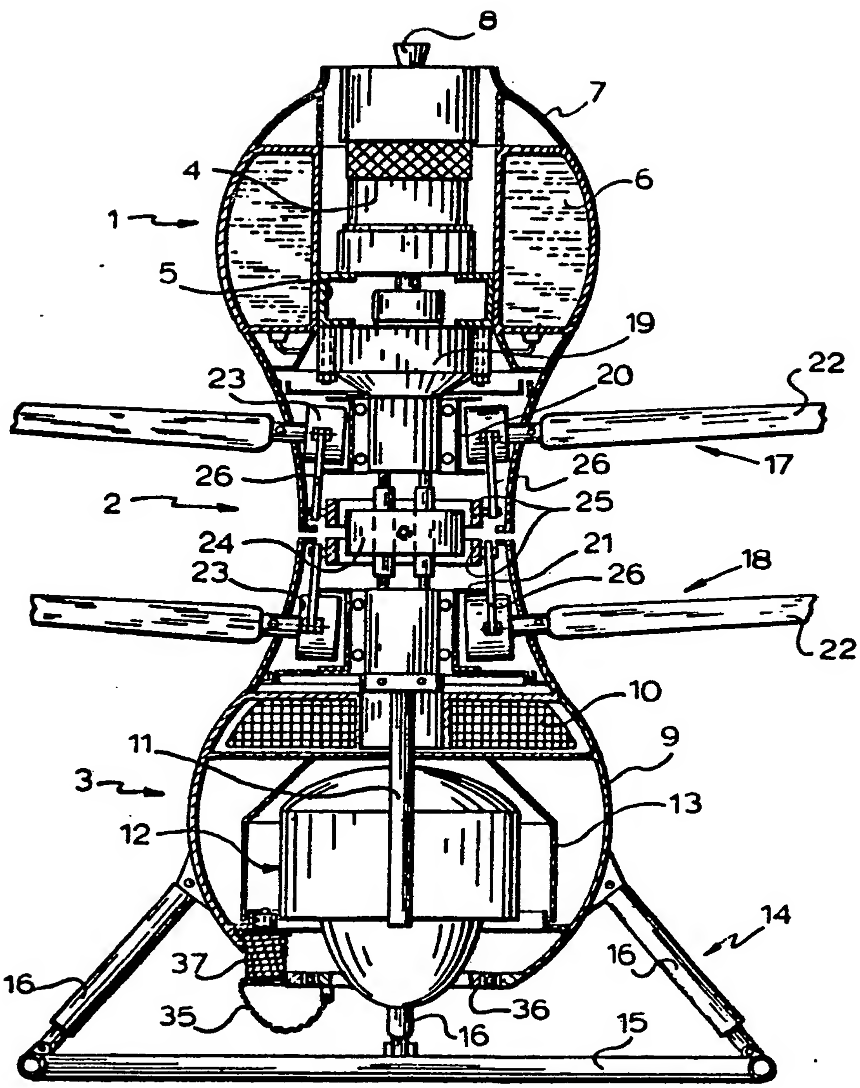
8
7
6
4
1
5
19
23
20
22
17
26
2
25
24
21
18
23
26
22
10
11
9
3
13
12
14
16
37
16
35
36
16
15

FIG. 1

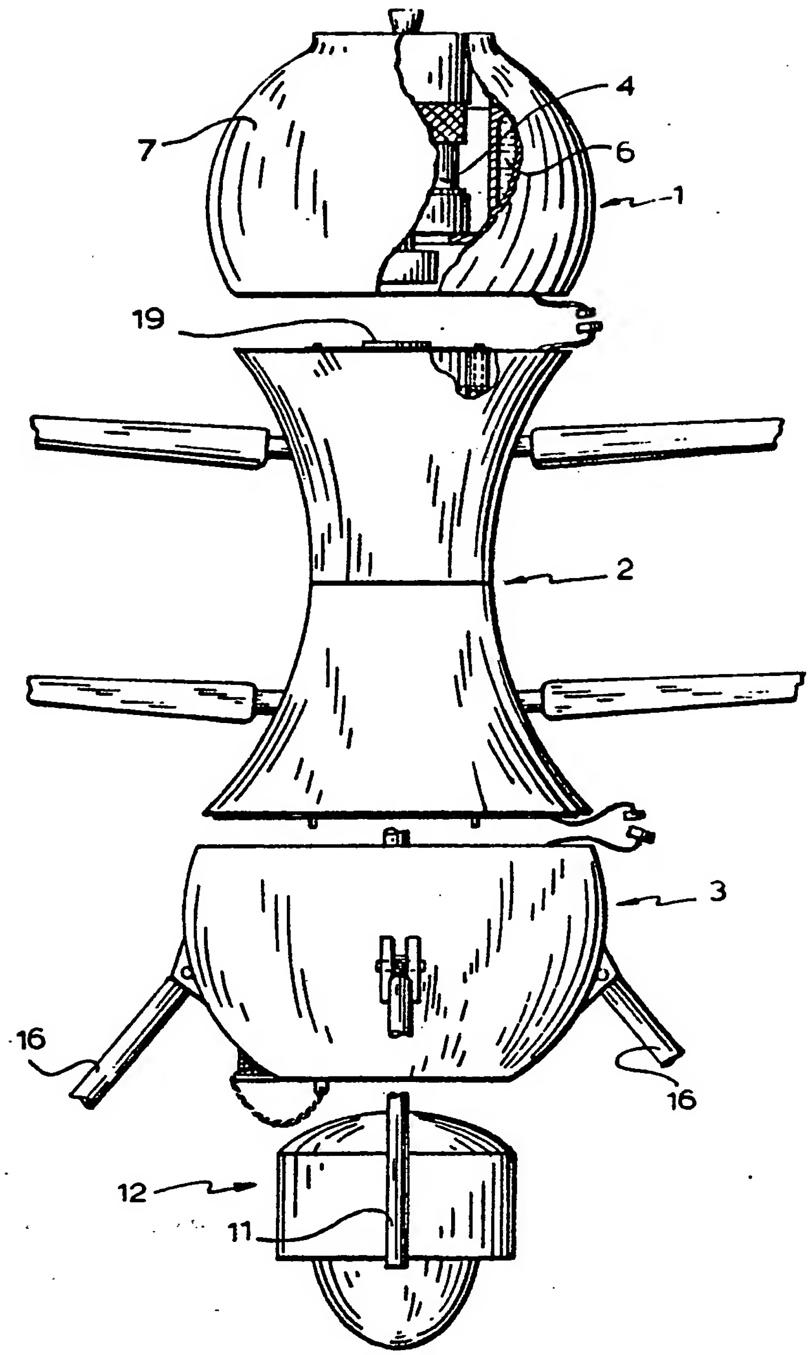

FIG. 2

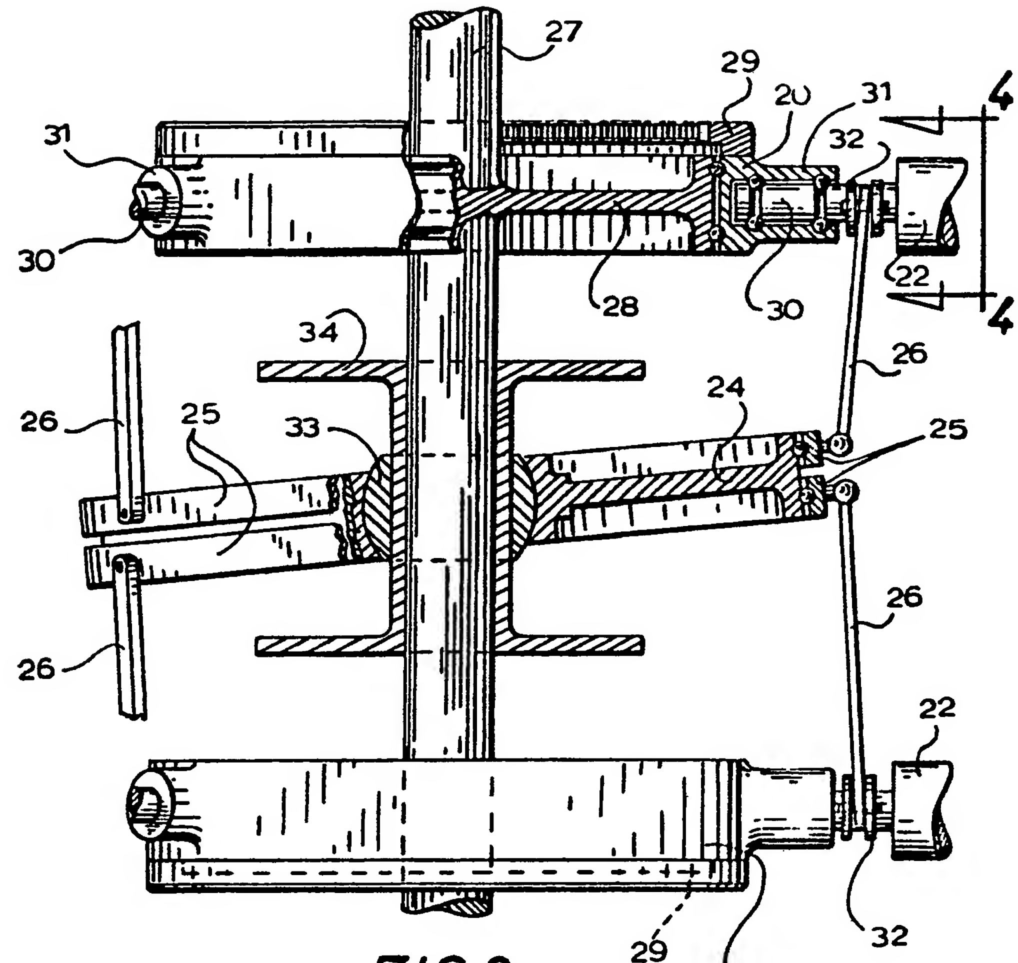
27
29
20
31
32
4
31
30
22
28
30
4
34
26
26
25
24
25
33
26
26
22
32
29
21

FIG. 3

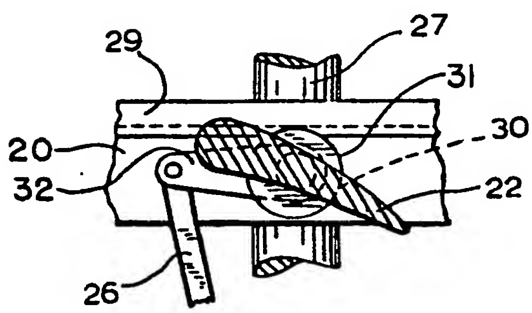
29
27
31
30
20
32
22
26

FIG. 4

SPECIFICATION
Unmanned remotely piloted aircraft

This invention relates to an unmanned aircraft more particularly of the remotely piloted type.

There have been conceived and/or produced many unmanned aircraft of the above type. So far, the efforts have produced workable units in particular concerning the flight and stability controls. In the known unmanned aircraft of the above type that have been conceived so far, the propulsion is achieved by helicopter like propellers positioned at the top of the aircraft and using non-rigid propellers to achieve the desired flight and attitude controls and in particular using differential collective pitch control. Such propellers produce a relatively small control output resulting in an undesirable limitation against strong moments on the aircraft such as when a tether line is attached to hold it captive.

The unmanned aircraft of the above type are more commonly conceived for warfare use on the battlefield and for that purpose they must be as difficult as possible to detect by the enemy; visually, by radar, or by infra red.

It is a general object of the present invention to provide an unmanned remotely piloted aircraft that includes active flight and stability controls producing relatively large moments sufficient to counter the large moment produced on the aircraft by a tether line holding it captive.

It is another general object of the present invention to provide an unmanned remotely piloted aircraft that is made with an appropriate configuration combination and outline of its major components one relative to another to minimize the possibility of its detection such as by the enemy.

It is a more specific object of the present invention to provide an unmanned remotely piloted aircraft combination that is made with counter rotating propellers positioned substantially at the height of the center of mass of the combination and to thus achieve the above mentioned general objects of the present invention.

It is a still more specific object of the present invention to provide an unmanned remotely piloted aircraft combination that uses rigid counter rotating propellers positioned substantially at the height of the center of mass of the combination to allow larger control moments which thus cope with large unbalance moments such as produced by a tether line holding the aircraft captive.

It is a still more specific object of the present invention to provide an unmanned remotely piloted aircraft that allows to have a configuration with counter rotating propellers positioned at intermediate height between the top and bottom thereof and also with two generally spheroidal surfaces above and below the propellers for minimum exposure to detection by radar reflection and the like due to the inherent dispersive nature of such surfaces.

The above and other objects and advantages of the present invention will be better understood with reference to the following detailed description of a preferred embodiment thereof which is illustrated, by way of example, in the accompanying drawings; in which:—

Figure 1 is a cross-sectional view in elevation of an unmanned aircraft according to the present invention;

Figure 2 is an exploded elevation view of the same aircraft to illustrate its modular concept; and

Figure 3 is an elevation view partly in cross-section of the propellers, blades and swashplate interconnection shown in a larger scale and in a slightly different embodiment than in Figure 1.

The illustrated remotely piloted unmanned aircraft comprises a body that is symmetrical about a vertical axis. That aircraft body comprises vertically superposed sections including an uppermost section 1, an intermediate section 2, and a lowermost section 3. Each of these sections constitutes a separable module constructed and arranged to be readily disconnected for maintenance or replacement.

The uppermost module or section 1 includes a rotary internal combustion engine or turbine 4 fixedly mounted on a supporting bracket 5. A generally annular or doughnut shaped gas tank is positioned around the engine 4 and is thus used to shield the hot parts of the engine against infra red detection. The outside of the body is provided with a housing or shell 7 having a generally spheroidal outline to be the least susceptible to radar detection. This is so due to the inherent high dispersive nature of spheroidal surfaces to radar waves or reflections. The exhaust outlet 8 for the engine 4 is positioned at the top of the uppermost section and thus also of the whole body of the aircraft and is upwardly directed to be concealed against infra red detection from the ground, down below.

The lowermost section or module 3 is also provided with a housing or shell 9 of generally spheroidal outline in which is housed the necessary flight control units, diagrammatically shown at 10. The control units do not form part of the present invention and therefore will not be described in the present patent application. Suspension brackets 11 are fixedly secured at their upper end, inside the lowermost body section. These suspension brackets are constructed and arranged to releasably support a payload 12 that is pivotally suspended by the brackets, in any well known manner. The payload 12 in this case constitutes a data requisition package for remote control of the vehicle and for surveillance of ground sites such as for enemy surveillance on a battlefield, for traffic surveillance, or for other civil uses. A shielding hood 13 is provided over and around the data acquisition payload 12.

A landing gear 14 is attached to the exterior of the lowermost section 3 and includes a landing ring 15. The latter is connected to the lowermost

body section 3 by means of three legs 16 each of the form of a shock absorbing strut that is pivotally connected at its opposite ends to the lowermost body section and to the landing ring respectively.

The intermediate body section 2 includes a pair of counterrotating propellers 17 and 18 and the associated control mechanisms shown in greater details in Figure 3. A gearbox 19 is centrally mounted at the top of the intermediate body section, and through appropriate shaft and gearing arrangement, not shown, it drives the top propeller hub 20 in one direction and the bottom propeller hub 21 in the opposite direction. Each propellel 17, 18 includes 3 blades 22 having each a hub portion 23, as shown in Figure 1 rotatively mounted in its corresponding propeller hub 20 or 21.

The collective and cyclic pitch control mechanisms illustrated in Figures 1 and 3 are essentially the same with only some secondary differences. The embodiment of Figure 1 will first be described in details. As shown in Figure 1, the collective and cyclic pitch control mechanism is connected to the blades 22 to selectively vary the pitch angle of each blade around its blade pitch control axis defined by the corresponding blade hub 23. A swash plate 24 is mounted between the two counterrotating propellers and is tiltable by any appropriate means, not shown in two orthogonal directions corresponding to the selected pitch and roll directions of the aircraft. A pair of rings 25 are rotably attached to the swashplate to rotate coaxially around it in well known manner. A blade pitch actuator arm 26 is pivotally connected, for each blade 22, at one end to the corresponding blade hub 23 and at the other end to the corresponding ring 25 to vary the blade pitch in relation with bodily tilting of the swashplate and rings for cyclic pitch control or in relation with bodily up or down displacement of the swashplate and rings for collective pitch control, all as is well known in the art.

The collective and cyclic pitch control mechanism illustrated in Figure 3 represents a slightly different embodiment compared to the embodiment in Figure 1 and more specifically defines how the propeller hubs 20, 21 and the swashplate 25 are mounted in the vehicle or aircraft body. The latter is provided with a fixed central shaft 27 having fixedly secured thereto spoked wheels 28 around which are rotatably mounted the propeller hubs 20 and 21 respectively. Each of the propeller hub 20, 21 carries a ring gear 29 that is driven by the engine 4 through appropriate pinion and shaft drive, not shown. In this embodiment, each blade 22 has a hub portion 30 rotatably engaged in a radial projection 31 of the corresponding propeller hub. A lever 32 is fixed to each blade hub 30, as in the embodiment of Figure 1, for connection of the blade pitch actuation arm 26 to it.

In this embodiment of Figure 3, the swashplate 24 is shown tiltably mounted on a ball joint 33 fixed to a spool shape support 34 that is slidable along the shaft 27. Thus the vertical sliding of the support 34 produces the same displacement of the swashplate 24 and collective control of the blade pitch angles.

A tether line 35 is attached to the lower end of the aircraft more particularly by one of its ends attached to a ring 36 that is mounted on ball bearings to freely rotate relative to the body of aircraft. The tether line is coiled on a spool 37 that is releasably carried by the aircraft during a flight. Any remote controlled releasable latch system is provided to releasably hold the spool onboard during flight. When desired for landing, the spool 37 is remotely unlatched or released to allow it to fall to the ground where the tether line is then pulled on to safely and guidably land the aircraft independently of adverse weather conditions and excessively accurate control performance.

Claims

1. An unmanned remotely piloted aircraft comprising, in combination,
   a body that is substantially symmetrical about a vertical axis,
   a pair of counterrotating propellers vertically positioned substantially at the height of the center of mass of the combination, fixedly positioned and rotatable about relative to the vertical axis of symmetry of the body, and including at least three blades, and propeller hub means operatively carrying the three blades,
   each of the blades including a blade hub portion rigidly integral therewith, defining a blade pitch control axis, and fixedly positioned relative to the propeller hub means and rotatable about the corresponding blade pitch control axis, and
   means to collectively and cyclically control the blade pitch angles of the propellers and constructed and arranged to exclusively provide thrust and pitch and roll moments.
2. An unmanned remotely piloted aircraft as defined in claim 1, wherein said body comprises separable sections defining
   an uppermost section including an engine laterally shielded by a fuel tank,
   an intermediate section including the counterrotating propellers, and
   a lowermost section including a payload.
3. An unmanned remotely piloted aircraft as defined in claim 2, wherein a quick connect-disconnect connection joins each of the uppermost and lowermost sections to the intermediate section and is constructed and arranged for quick separation of either section from the other sections.
4. An unmanned remotely piloted aircraft as defined in claim 3, wherein the intermediate section includes a gearbox openly accessible at the top thereof and the quick connect-disconnect connection joining the intermediate section to the uppermost section is operatively connected to the gearbox and firmly joins the intermediate section to the uppermost section.
5. An unmanned remotely piloted aircraft as defined in claim 4, wherein the uppermost section

includes an exhaust outlet connected to the engine and outwardly opening at the top of said body in substantial concealment from infra red detection from the ground.

6. An unmanned remotely piloted aircraft as defined in claim 1, 2 or 5, further comprising control means constructed and arranged to produce cyclic change of the propeller blade pitch angles to generate moments to control and stabilize the attitude of the body axis of symmetry with respect to vertical, control means constructed and arranged to produce collective change of the propeller blade pitch angles to control the level of thrust produced by the propellers and control means constructed and arranged to produce differential speed of the two propellers to generate torque rections on the body to control and stabilize the orientation of the body around the axis of symmetry.

7. An unmanned remotely piloted aircraft as defined in claim 1, 2 or 5, further comprising a tether line including a coil releasably deployable from said body, having one end remaining operatively connected onboard; and being constructed and arranged for captive landing of the aircraft upon pulling on the released tether line.

8. An unmanned remotely piloted aircraft as defined in claim 7, wherein said uppermost and lowermost sections are of generally spheroidal outline.

9. An unmanned remotely piloted aircraft substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained